Upper Patuxent

Watershed Study

Montgomery County MD
Department of Environmental Protection
Watershed Management Division

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Executive Summary

The Upper Patuxent River is a natural boundary dividing Montgomery and Howard County. In the year 2000, Montgomery County Department of Environmental Protection monitored fourteen stations along the mainstem and its tributaries. Certain parameters including fish, benthic macroinvertebrates, habitat, temperature, and water chemistry were sampled to help develop an understanding of the overall stream health. Several water quality results were compared to the Maryland Department of the Environment Use III stream classification criteria for this portion of the Patuxent. Water chemistry results all fell within desired ranges with the exception of a low percent saturation taken at station UPPR207 on 8/16/2000. Rapid habitat results all scored in the *good* to *excellent* range. IBI scores for the fish community showed that four sites (UPPR201A, UPPR207, UPPR208, and UPHR201) were areas that needed to be more closely examined. The main limiting factor for the fish appears to be a small drainage area. Even though there is not enough flow to sustain a healthy diverse fish community, the benthic macroinvertebrates have scored *excellent* or *good* in all sites. Five temperature loggers were place in the various areas of the river to record temperature over roughly a 3-4 month period every 26 minutes. The results showed that all sites exceeded the MDE established criteria at various readings, but never remained over the 20ºC reading for any length of time. The high spikes may be due to sites being downstream of open agricultural areas, and of roads, both which would allow for temperature rises in the water. Quantitative habitat surveys were conducted in fall/winter of 1999, and showed that seven of the eight stations surveyed were entrenched to moderately entrenched.

It is recommended that riparian buffers be examined and increased to ensure better protection to the streams. Increased buffers slow down degradation of stream banks, and should help to keep water temperature with in a desired range. Follow up quantitative habitat surveys should be conducted along with temperature monitoring. Even though the biological community is not showing adverse affects from the various levels of entrenchment, this may eventually harm both the benthos and fish communities. No follow up physiochemical monitoring is recommended at this time.

Summary

The Purpose of this report is to:

- Assess the existing stream conditions of the Upper Patuxent River,
- Identify stream reaches with impairment from other habitat stressors,
- Identify stream reaches with unstable habitat features that, if left alone, could further degrade the biological community of the stream,
- Provide recommendations for follow up actions concerning the identified areas of impaired stream reaches.

Introduction to the Watershed (excerpted from the Countywide Stream Protection Strategy)

Upper Patuxent River Watershed

The Upper Patuxent River forms the boundary between Montgomery County and Howard County and includes all the land draining to the Patuxent River above the Triadelphia Reservoir. The watershed on both sides of the river includes large forested areas along with agricultural cropland, pasture, and large-lot rural residential development(Figure 1).

For many, it is hard to believe that this small, high quality, clear flowing cold water stream is the same Patuxent River entering the Chesapeake Bay at Solomons, Maryland. Since the 1970's, the Patuxent River and its watershed have been the subject of many planning and technical studies, but until recently these studies have emphasized the tidal and the noontide to tidal transition areas of the River which are located far downstream.

The Patuxent River originates in Frederick County, above the intersection of Route 27 and Windsor Forest Road. In the stream above Route 94 is a naturally reproducing brown trout population. To protect this resource, the Upper Patuxent has been designated a special trout catch and release stream by the Maryland Department of Natural Resources. The brown trout population is part of a generally high quality cold water fish community, although sculpins, which are usually found in these communities, are absent. Extensive forested areas in the Patuxent River State Park surround the Upper Patuxent. Areas of the state park are or will soon be designated as Maryland Wildlands. The mature floodplain and upland forests support a rich wildlife community with some of the best forest interior breeding bird habitat remaining in the County. The streams in this watershed are among the best remaining in the County and many serve as reference streams for the County's stream monitoring program.

There has been some concern about accelerated rates of sedimentation, elevated nutrient levels, and depressed dissolved oxygen concentrations being observed at Triadelphia and Rocky Gorge Reservoirs. These two reservoirs supply over 11 billion gallons of drinking water to suburban Montgomery County and Prince George's County, and to a limited extent, Howard County. In March 1995, the interjurisdictional Patuxent Reservoir Protection Group published an interim report on the desired components of a Patuxent Reservoir Protection Strategy. In October 1996, an interjurisdictional agreement among Howard, Montgomery, and Prince George's Counties, the M-NCPPC, the WSSC, and the Howard and Montgomery Soil Conservation Districts committed these agencies to develop and implement initiatives for long term protection of the Patuxent Reservoirs watershed including the water supply reservoirs, the Patuxent River and its tributary streams, and associated groundwater resources.

An interagency group has been working with a WSSC consultant to establish a framework for the various components of an integrated long-range watershed management plan. These components are expected to include hydrologic investigations, nutrient and sediment load quantification, water quality monitoring, watershed and reservoir model development, public awareness initiatives, control options, and progress tracking. The study and its recommendations were completed in July 1997 and presented to the Patuxent Agreement signatories in October 1997. The WSSC is also funding the publication of a newsletter to document recent activities and progress on protecting the reservoirs and their resources. The first newsletter was distributed to watershed residents during the fall of 1997.

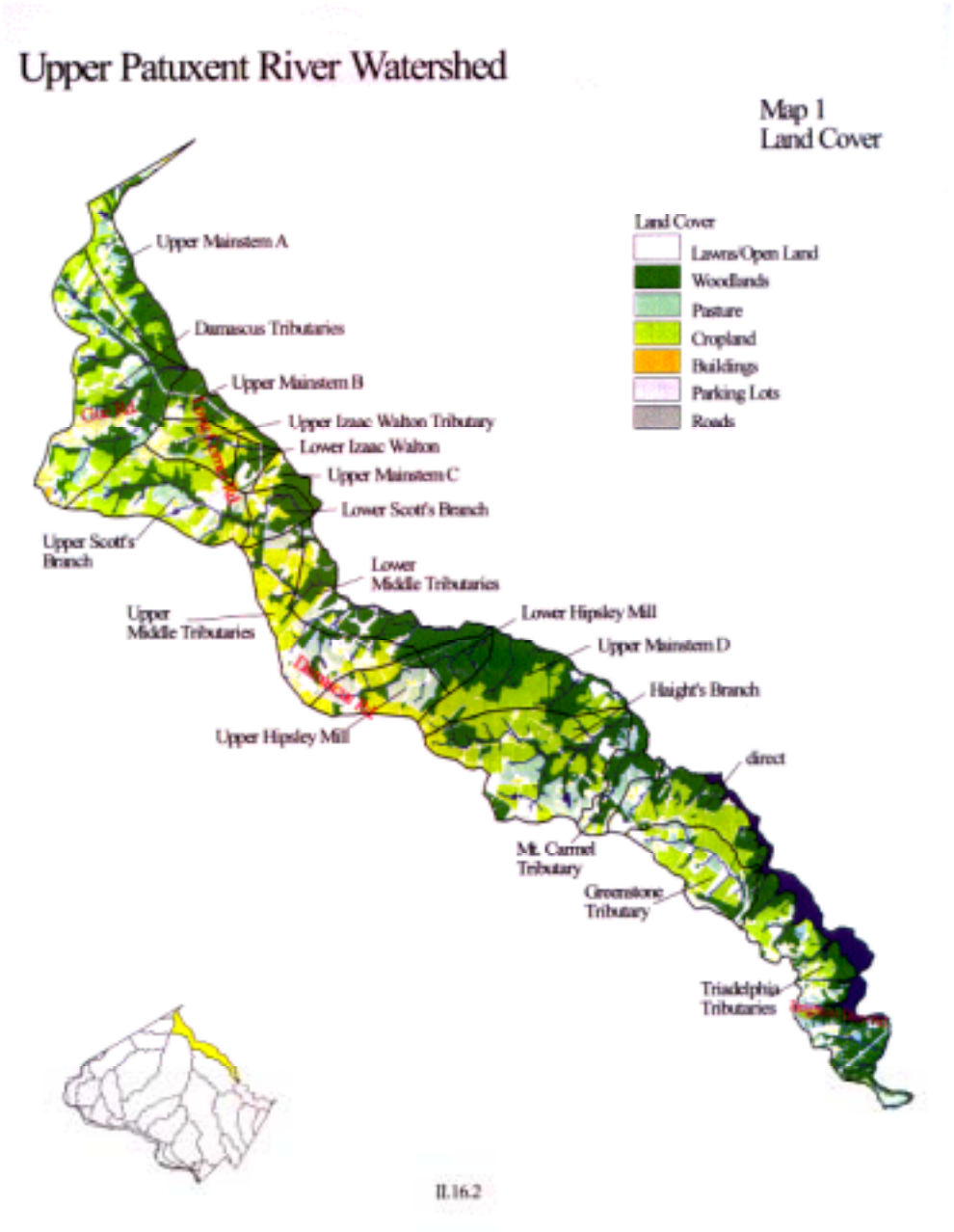


Figure 1. Land Cover for the Upper Patuxent River

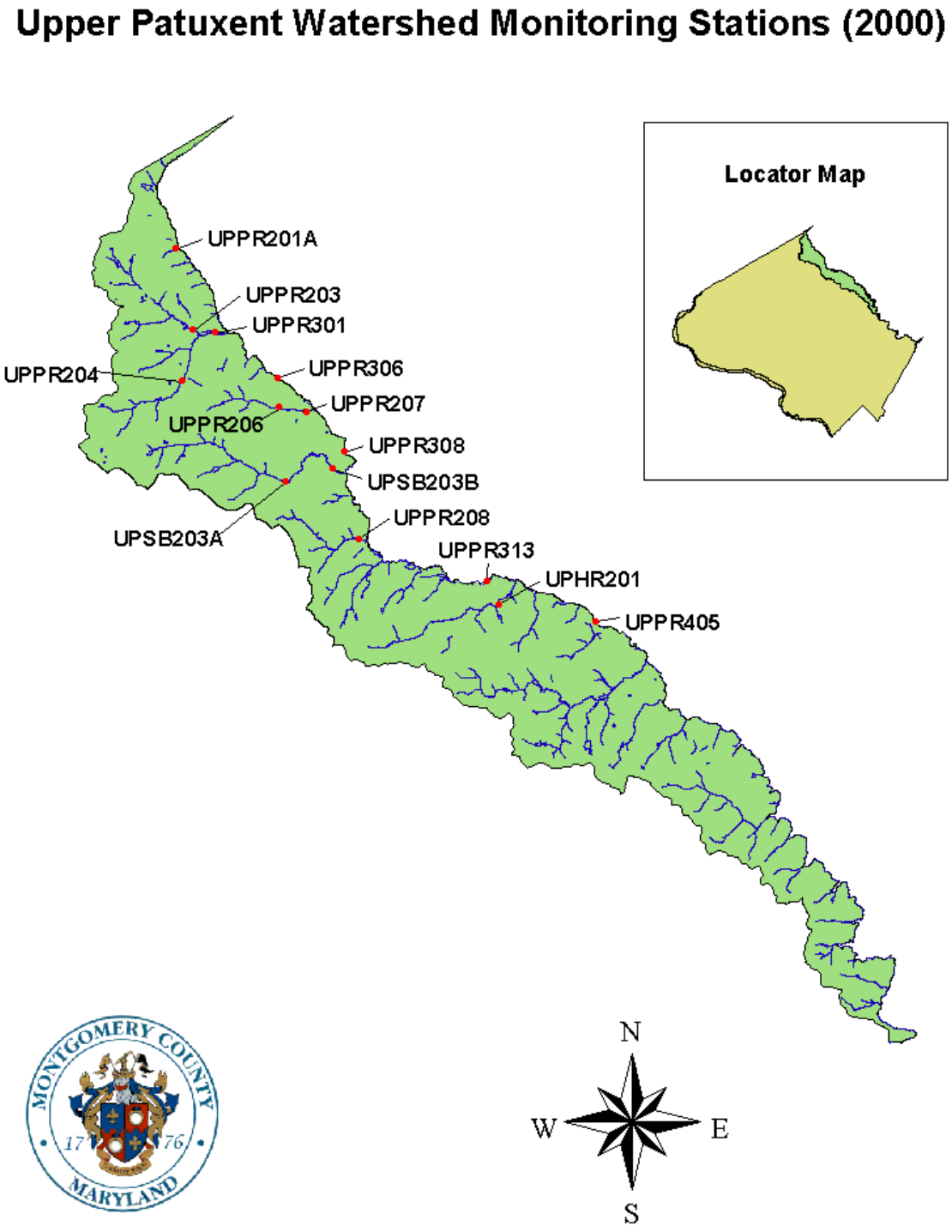


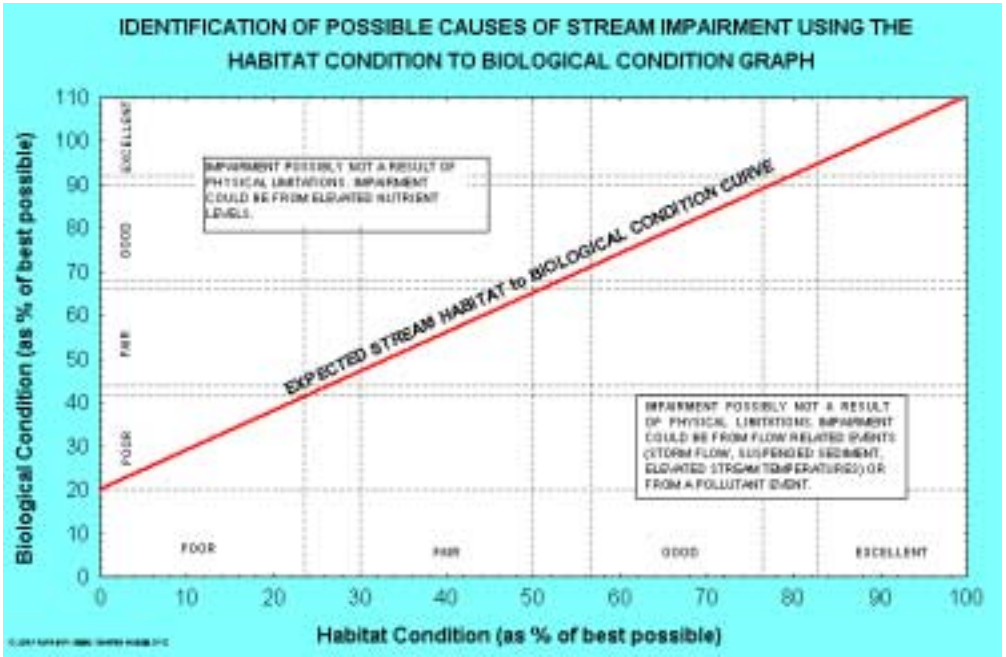
Figure 2. Monitoring Stations for the 2000 Monitoring Season.

Methods

All fieldwork, data reduction, and data analysis follow the stream monitoring protocols described in Van Ness et al 1997. The overall stream condition was determined by assessing the cumulative impacts that occurred in the watershed as indicated by the use of an interim Index of Biological Integrity (IBI) for freshwater fish and benthic macroinvertebrates. The stream condition was made by examining the trends expressed by the two IBI's. This is not the same as averaging the two scores. Seasonal trends were examined and a yearly stream condition has been established for the subwatersheds.

Assuming that water quality is constant throughout the study area, the relationship between habitat quality and biological condition can be predictable, (Barbour et al, 1998), and provide diagnostic information on stressors likely responsible for identified impairment to the existing stream area. Possible causes of impairment can be determined by examining the relationship between the IBI score / habitat score for each individual monitoring station (Figure 2). Percentage of the best attainable biological condition was calculated for each IBI score and compared against percentage of the best attainable instream physical habitat in order to assess relationships between habitat and biology and identify areas of stream impairment from other than physical stressors (Figure 3). The theoretical regression lines shown in Figure 1 describes the general relationship of biological condition to habitat quality in the absence of water quality effects. The highest possible IBI score for fish is 50 (100%), for benthic macroinvertebrates 40 (100%). Abiotic factors such as water temperature, water chemistry, and analysis of both qualitative and quantitative physical habitat attributes are also used to assess the types of stressors that may be affecting the system. Impaired sites are then targeted, and further investigations of the probable causes of impairment are scheduled.

Figure 3. Conceptual Relationship between habitat and Biological Condition



Results

Fourteen monitoring stations, located throughout the Upper Patuxent River, were used in preparation of this report. All sampling occurred in 2000, except for quantitative habitat, which was surveyed in 1999. Of the monitoring stations, two are on Scott's Branch tributary (UPSB203A and UPSB203B), one is located the on Hipsley Mill Run tributary (UPHR201), three are on the "Damascus Tributary" (UPPR203, UPPR204, and UPPR306), and two are on the "Isaac Walton League Tributary" (UPPR206 and UPPR207). The other five sites are considered to be mainstem sites. A total of six of these sites had fish IBI scores in the *excellent* to *good* range. Three of the sites scored in the *fair* range, and one of the sites scored *poor*. The rapid habitat assessment for all fourteen sites scored *excellent* and *good*.

Benthic macroinvertebrate sampling was conducted on all sites with the exception of UPPR206. All monitoring stations have scored *excellent* or *good* for the benthic macroinvertebrate IBI scores. Rapid habitat assessments scored in the *good* to *excellent* range.

While sampling at stations UPPR206 and UPPR207, a fish blockage was discovered. In between these two sites is a gabiom basket culvert that has scoured on the downstream side, causing about a 2-foot space between the culvert and substrate, blocking fish from moving upstream. Above the culvert an adult brown trout was found, which increased the sites fish IBI score. Below the culvert, no adult trout were found, but some juvenile trout were sampled. Juvenile trout are not included in the fish IBI; this gave the downstream station UPPR207 a lower IBI score.

Examination of IBI/Habitat Relationships

Fourteen stations were monitored for benthos in the spring and quantitative habitat was surveyed in the fall. Ten of these stations were fished during the summer. Rapid habitat scores during spring and summer for all fourteen sites were in the *excellent* to *good* range, as were benthic macroinvertebrate IBI scores. One of the sites located along Windsor Forest Road near the Howard County line (UPPR201A), another located off Annapolis Rock Road (UPPR208), and a station located off of Hipsley Mill Run along the power line (UPHR201), scored *fair* for fish, and site UPPR207 off of Mullinex Mill Road scored *poor* for fish, the remainder scored *good* to *excellent* (Figure 4a).

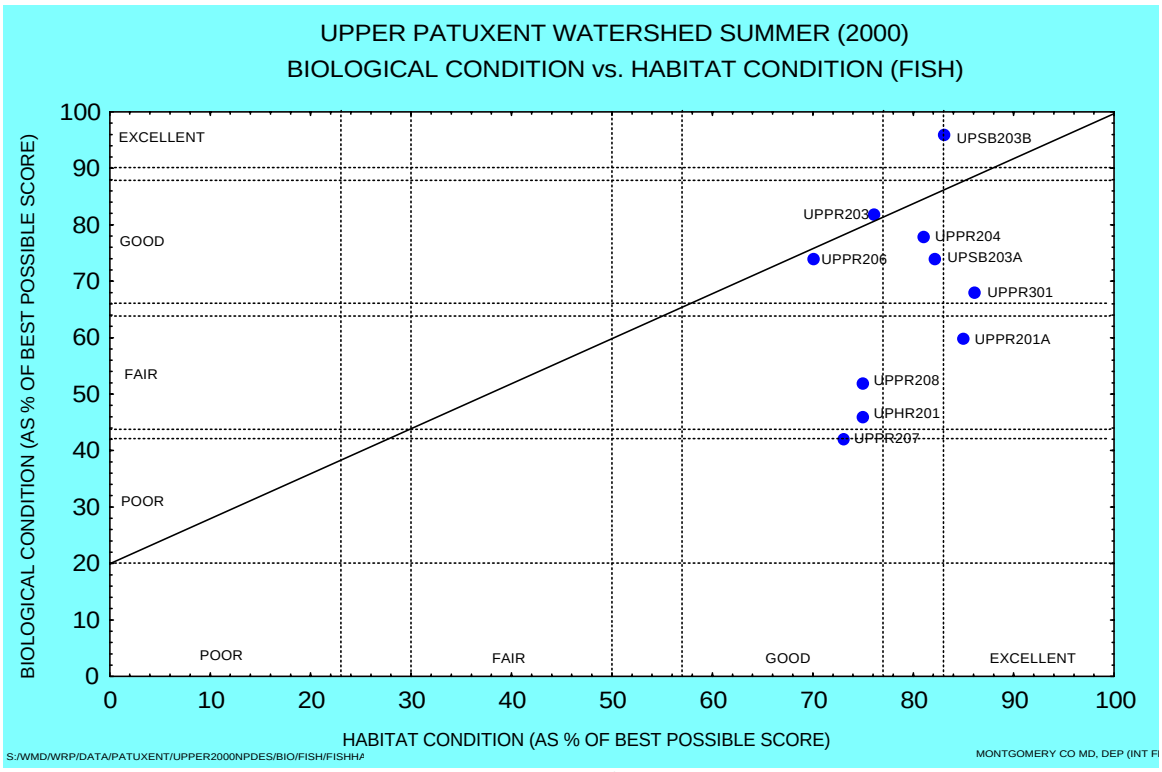


Figure 4a. Biological Relationships vs. Habitat as a Percentage of Best Obtainable Scores in the Upper Patuxent

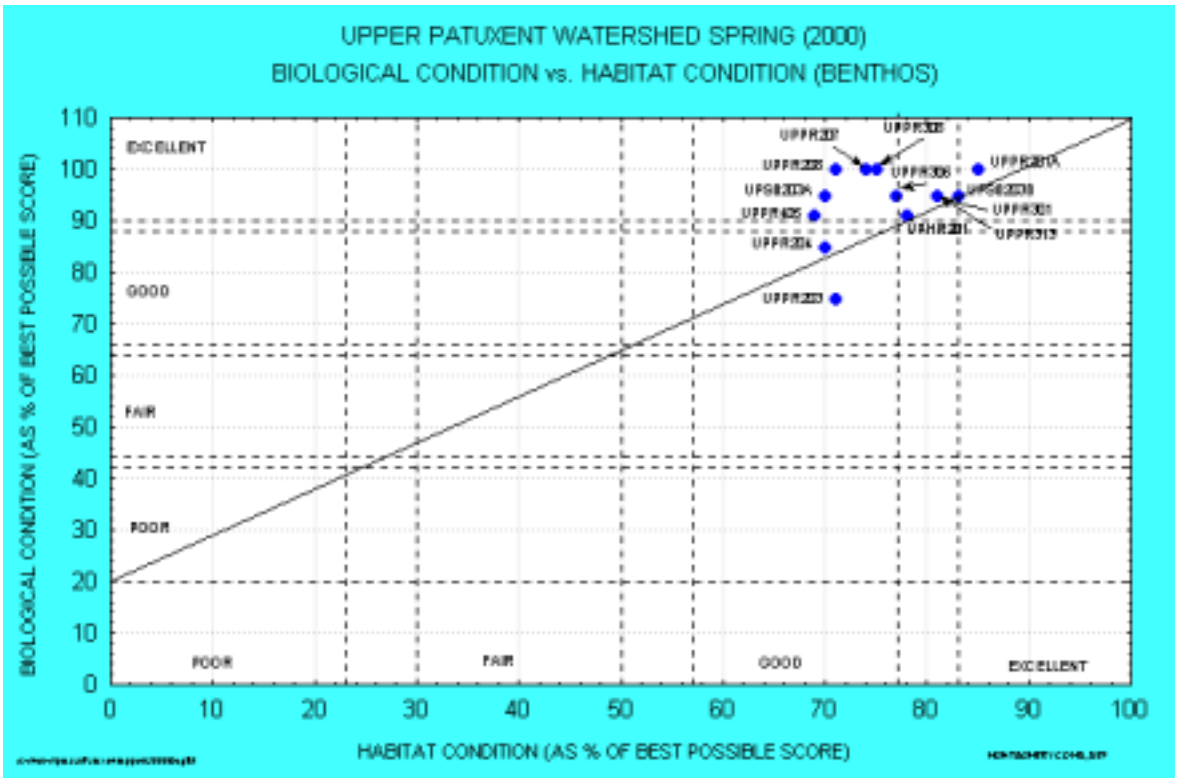


Figure 4b. Biological Relationships vs. Habitat as a Percentage of best Obtainable Scores in the Upper Patuxent

Stream Areas of Concern

Stations were identified as areas of concern because they plotted out of the *excellent / good* range on the expected Biology / Habitat relationship (Figure 4a)**.** Four stations (UPHR201, UPPR207, UPPR208, and UPPPR201A) scored lower than expected for the fish community (Table 1). All stations scored in the *excellent* to *good* range for the benthic macroinvertebrate IBI score (Figure 4b).

UPHR201 is located in the Hipsley Mill Run subwatershed roughly 1km upstream from the mainstem. Rapid habitat conducted during fishing and benthos sampling rated overall as *good* (150-138), and the fish scored as *fair*. UPPR207 is located on Mullinex Mill Run about 50 m above the mainstem. The rapid habitat assessment score was *good,* and the fish biology score was *fair*. Monitoring station UPPR208 is located off Annapolis Rock road, about 300m upstream of the tributaries confluence with the mainstem. This station scored a *good* in rapid habitat assessment and *fair* in fish biology. UPPR201A is located off of Windsor Forest Road on the mainstem a little more that 1km downstream. Rapid habitat assessment was *excellent,* and fish scored a *fair* (Figure 2).

Table 1. Stations Considered Areas of Concern

Monitoring Station	Location	Benthic IBI	Fish IBI	Recommended action
UPPR201A	Windsor Forest Rd	Excellent	Fair	examine habitat / temp / and buffers
UPPR208	Annapolis Rock Rd	Excellent	Fair	examine habitat / temp / and buffers
UPHR201	Hipsley Mill Run	Excellent	Fair	examine habitat / temp / and buffers
UPPR207	Mullinex Mill Road	Excellent	Poor	examine habitat / temp / and buffers

Rapid Habitat

Specific habitat parameters were further examined to see if individual parameters could explain some or all of the impairment observed in the fish and benthic community. Seven of the ten parameters used in the rapid habitat assessment were analyzed. These seven parameters have scores that are good indicators of impairment from habitat stressors. Three of the parameters were excluded for the following reasons. Channel alteration (channelization or dredging) is usually absent or minimal in County streams. Bank vegetation protection scores usually follow those of bank stability (stable banks support a healthy vegetative cover*)*. Finally, most riparian buffers in the County are 12 meters or greate*r*. Scores for these 3 parameters are usually in the good to excellent range at all monitoring stations.

Table 2. Selected habitat parameters (Rapid Habitat Assessment) at Areas of Concern

Monitoring Stations		Fish Cover	Benthic Substrate	Embeddedness	Sediment Deposition	Bank Stability	Flow Status	Riffle Frequency
UPPR201A	03/23/00	excellent	excellent	good	good	good	excellent	excellent
	08/25/00	excellent	excellent	good	good	good	excellent	excellent
UPPR208	04/25/00	good	good	good	good	good	good	excellent
	09/15/00	excellent	excellent	excellent	good	good	good	good
UPHR201	04/25/00	good	excellent	good	good	good	excellent	good
	09/18/00	good	excellent	good	fair	good	excellent	excellent
UPPR207	08/16/00	good	good	good	good	good	excellent	good

All the rapid habitat parameters for the areas of concern were with in the *excellent* to *good* range, except for sediment deposition in station UPHR201 which scored *fair* (Table 2). Overall, rapid habitat does not show any degradation that would affect the biological community.

Water Quality

Physiochemical parameters are measured each time the station is visited and are examined for any indication of impairment of water quality stressors (Table 3). The stream classifications determined by the Maryland Department of the Environment (COMAR 26.08.01-.04) for a Use III stream, was used to determine physiochemical and temperature parameter ratings for the monitored sites. The Patuxent River is a Class III stream and the following criteria apply: Dissolved oxygen levels must >=5.0 mg/L at anytime with a minimum daily average of not less than 6.0 mg/L., temperature is not to exceed 20 degrees C (68 degrees F) outside the mixing zone, and the pH must be between 6.5-8.5. The majority of the parameters for these sites were within normal range. Site UPPR207 had a percent saturation under the desired range, in August (75%), and may be a result of low stream flow. Further examination of quantitative habitat and drainage area for this station may help to determine stream flow problems.

Table 3. Physical parameters for areas of concern

STATION	DATE	TIME	DISOXY (ppm)	PCT_SAT (%)	PH	COND (umhos)	AIRTEMP_C	H2O TEMP_C	COMMENTS
ideal parameters			>=5mg/L	>80%	6.5-8.5	<=300			
UPHR201	04/2000 Spring	12:05					13.5	11	Hydrolab stopped working
UPHR201	09/2000 Summer	13:20	9.68	93	7.1	95	23.8	14.53	
UPHR201	11/1999 Winter	13:15	13.19	98	5.4	50	5	3	
UPPR201A	03/2000 Spring	10:40	11.29	95	7.6	117	13.5	9.07	
UPPR201A	08/2000 Summer	10:05	8.89	90.8	7.2	293	23.8	17.08	
UPPR201A	10/1999 Winter	14:09	9.85	87	6.8	22	22	10.8	
UPPR207	08/2000 Summer	12:00	7.04	75	7.1	129	30	17.98	
UPPR207	11/1999 Winter	12:31	10.52	89	7.1	129	10.5	8.9	
UPPR208	04/2000 Spring	14:12					15	10.5	Hydolab stopped working
UPPR208	09/2000 Summer	15:10	8.53	89.2	7.0	126	23.8	17.5	
UPPR208	11/1999 Winter	12:37	11.53	104	6.9	92	20	10.6	

Quantitative Habitat Analysis

Quantitative habitat was surveyed during the fall of 1999. Analysis of these measurements can provide further information as to whether or not a habitat limitation, physical impairment, or water quality impairment is potentially influencing the fish and benthic macroinvertebrate communities. In addition, habitat data was examined to see if any areas of accelerated habitat instability were observed. Entrenchment and bankfull width-depth ratio calculations and interpretation follows Rosgen (1996).

The entrenchment ratio is the flood prone width divided by the bankfull width. The more entrenched the site is, the lower the number. The flood prone width is the surrounding area that allows relief to the stream during high water. When the area of stream is entrenched, the floodplain is no longer accessible, causing the flow to funnel through the stream resulting in erosion and degradation of biological habitat. The width / depth ratio is the bankfull width divided by mean bankful depth. This

Figure 5a. Example of entrenched site with a low width depth ratio.

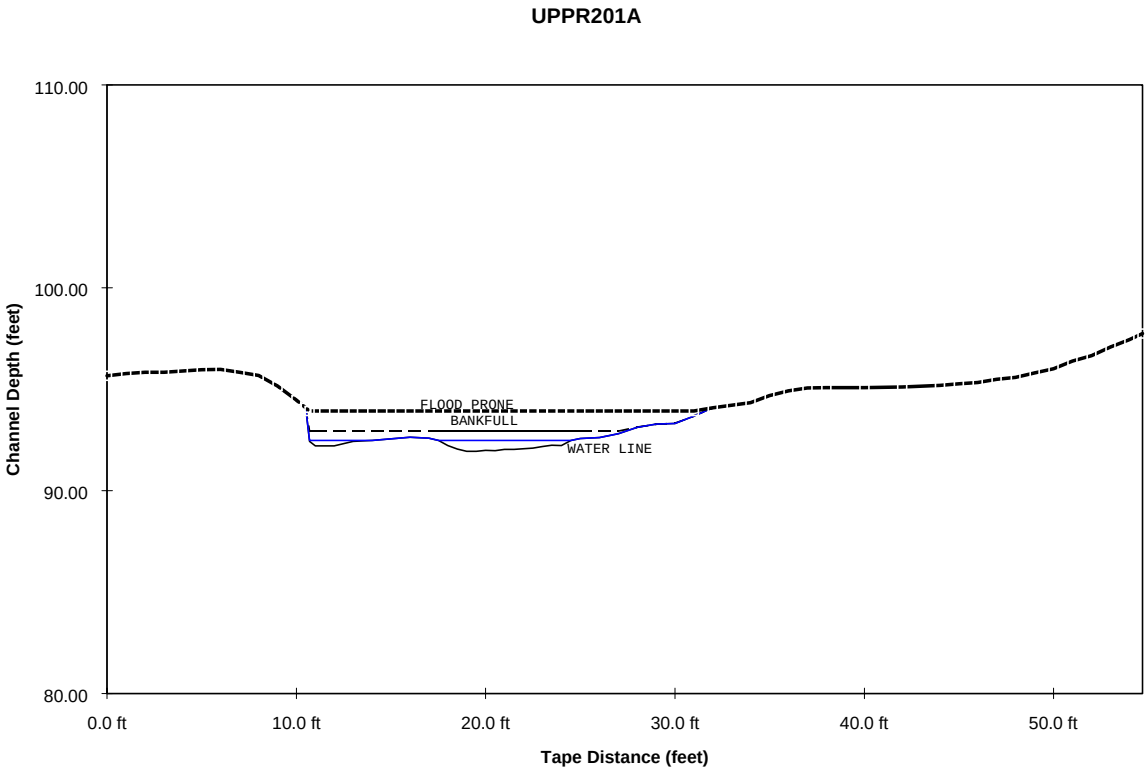
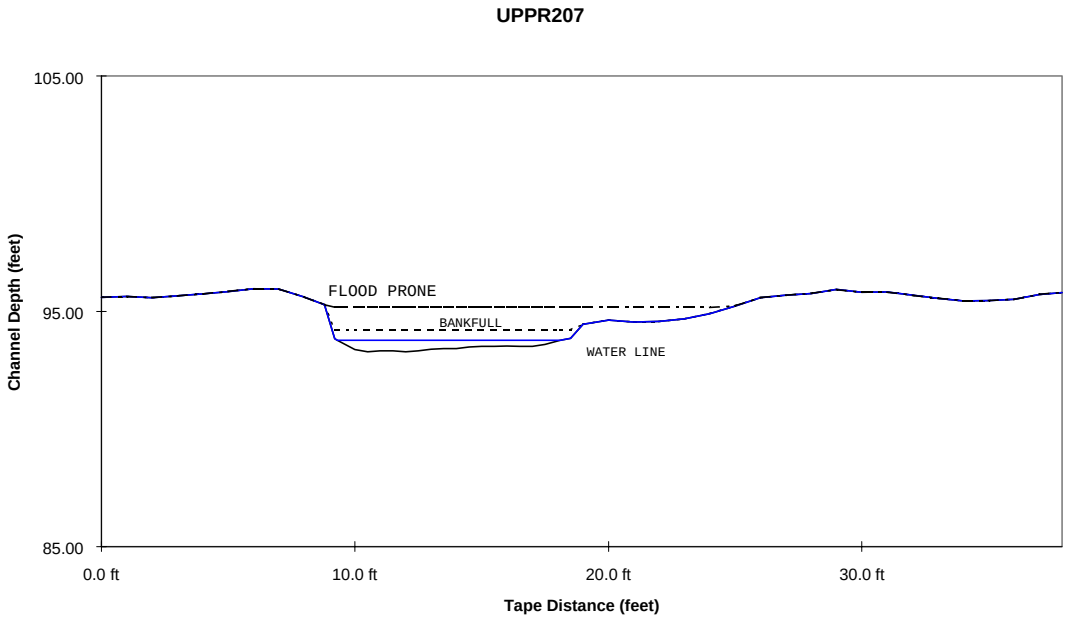


Figure 5b. Example of a moderately entrenched site with a moderate width / depth ratio.



ratio explains the distribution of energy with in the channel. These two ratios are used together as a good representation of the physical stream condition.

Stations UPPR201A and UPHR201 are entrenched sites with a low width / depth ratio (Figure 5a). This would cause degradation in the fish community. As an area of stream becomes entrenched there tends to be unstable banks causing sedimentation in the creek, resulting in loss of fish and benthic macroinvertebrate habitat, along with no place of refuge during high water events for the fish community. UPPR207 is moderately entrenched with a moderate width / depth ratio (Figure 5b). Again, the moderate entrenchment will cause somewhat unstable banks, resulting in sedimentation and negative effects on the biological community. Station UPPR208 is only slightly entrenched with very low width / bank ratio (Figure 5c). The entrenchment ratio and width / bank ratio shows that the habitat at this site is not what is causing degradation to the biological community.

Figure 5c. Example of a slight entrenched site with a low width / bank ratio.

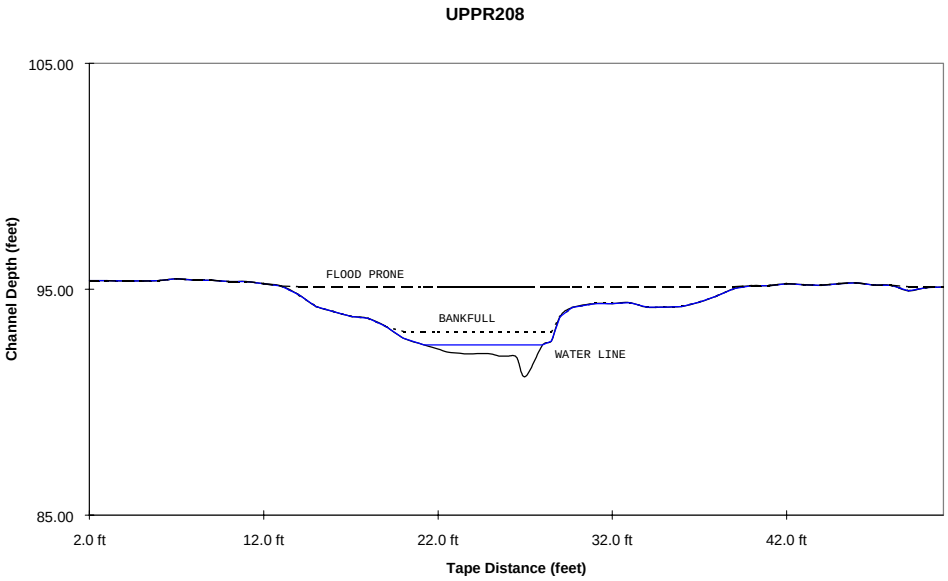
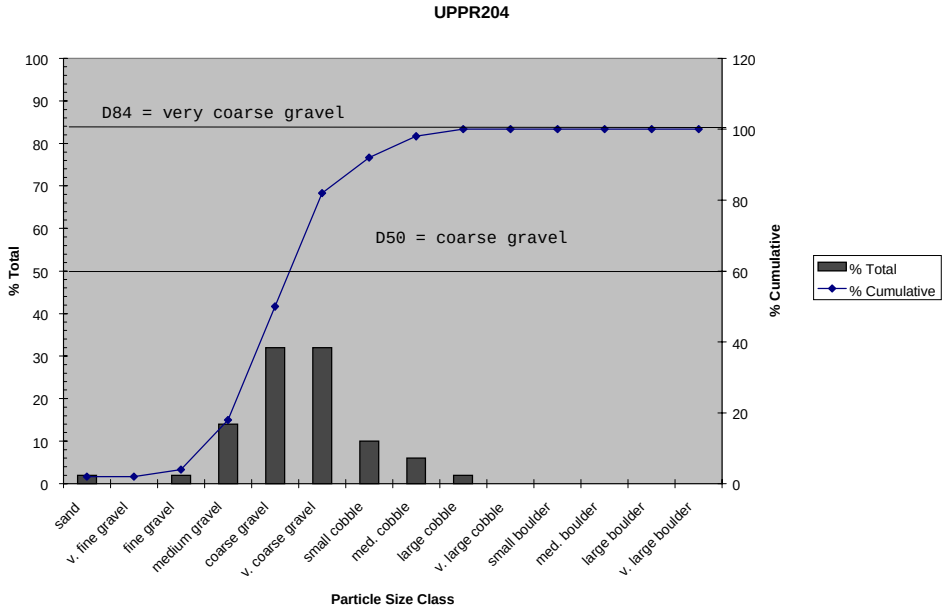


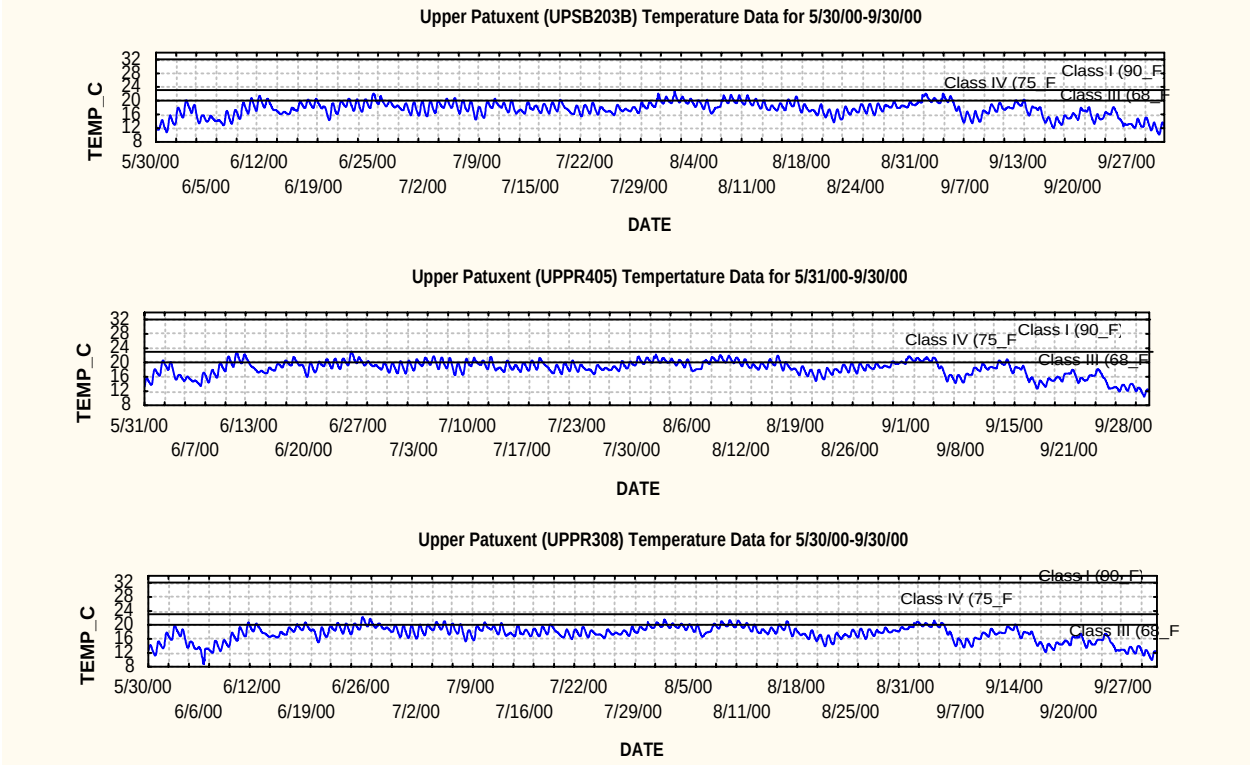
Figure 6. Analysis of Pebble Counts at Station UPPR204.



Particle size in the riffles is directly correlated to the health of the benthic macroinvertebrate community, which is in turn related to the well being of the fish community. Pebble counts are conducted on the riffles during the quantitative habitat survey. If particle size consists of small gravel and sand, it becomes a limiting factor in the benthos community. The median particle size (D50) in the coarse gravel classification ids the desired range (Figure 6). All sites had adequate particle class and diversity to sustain a healthy macroinvertebrate population.

Temperature

Temperature loggers provide information on any possible irregularities, as in accordance with the Maryland Department of the Environment (COMAR 26.08.01-.04) in water temperature, that may affect the biological community. The desired maximum temperature is <20ºC. This is the ideal maximum temperature to sustain a healthy trout population, as found in the Patuxent River. It is not abnormal to see some high spikes in the data throughout the day, and as long as temperature does not remain at a constant high it is not of concern. Loggers were placed in five of the fourteen monitoring stations (Figure 7). Most were put in the stream at the end of May and recorded temperatures every 26 minutes until the end of September. UPPR207 is one of the "stream areas of concern" that had this parameter was monitored. The temperature did rise above the 20ºC mark on a few readings, but this is not abnormal. The temperature never stayed above the 20ºC mark for a full 24 hours, and only peaked once up to near 23ºC. The other four stations also showed high spikes in water



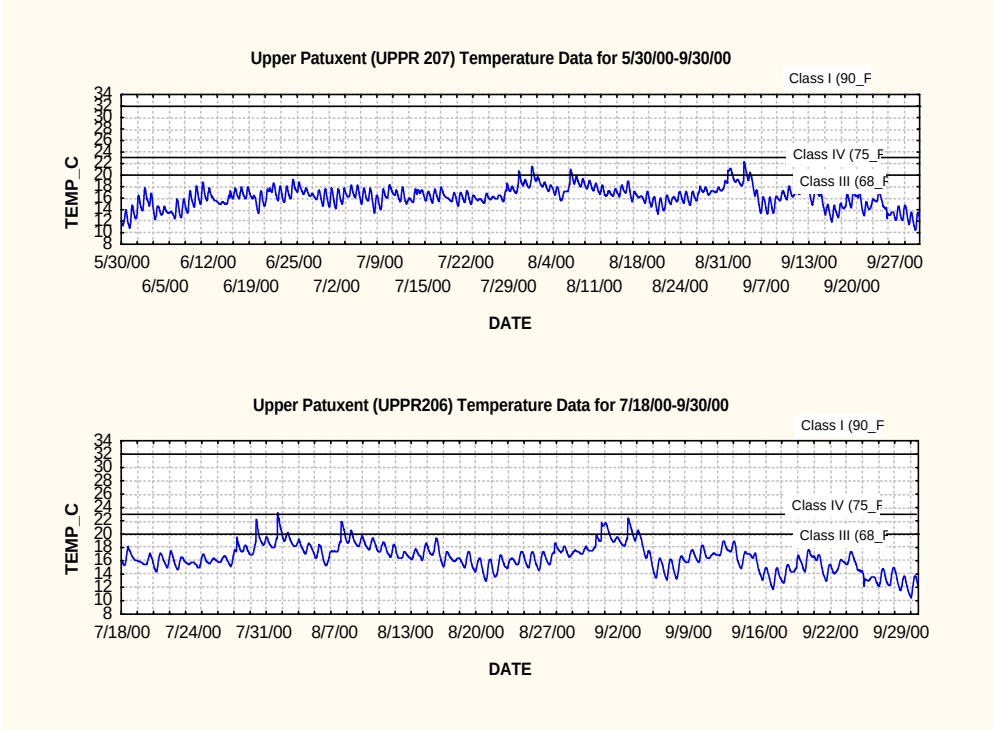


Figure 7. Temperature logger analysis

temperature. None of these spikes lasted for a 24-hour interval, and do not seem to have an affect on the biological community.

Drainage Area

The drainage area is the amount of area that drains into each station of the watershed. A small drainage area is considered to be 300 acres. This parameter was examined for the four areas of concern. UPPR206 and UPPR208 have their entire drainage area with in Montgomery County. UPPR206 has a drainage area of 378.0 acres, and UPPR208 has a drainage are of 513.0 acres. Acreage of drainage area for stations UPPR201A and UPHR201 are not available because it is located partially in Howard County, and we do not have the precise information. All four stations have a relatively small drainage area, and therefore low flow. As where low flow this may not affect the benthos community, it can make it difficult for a healthy fish population to survive.

Discussion

The Upper Patuxent Watershed is in overall good condition. Of the fourteen stations monitored, four show impairment to the fish community. The monitoring stations UPHR201, UPPR207, UPPR208, and UPPR201A), were categorized as areas of concern due to fish IBI scores rating *fair* to *poor*. Different parameters were examined and in all cases the main limiting factor at these sites appears to be the drainage area. The amounts of flow in the areas of concern are too low to sustain a diverse fish community. Drainage area is not a parameter that we can adjust, but these are areas we can monitor to ensure that sedimentation and habitat degregation cause no further limiting factors.

Quantitative habitat surveys were conducted at all fourteen sites discussed in this report. All but one portion of stream surveyed, site UPPR208, showed to be entrenched to moderately entrenched. This presently does not show an effect on the benthos community or on the fish community, but in time there is a possibility it may. A usual cause of entrenched streams is a poor riparian buffer, or lack of bank stabilizing plants such as tree roots and shrubs. Without protection to the banks, they will degrade resulting in eventual biological habitat impairment. Most of the Upper Patuxent River is in forested area with good riparian buffers on both sides. It is a natural process for streams to erode and shift, and naturally work themselves back into what we consider a healthy habitat to sustain a productive biological community. But there are also ways we can try to prevent further degradation. Upstream of many of these sites are agricultural areas and roads. It is recommended that buffers be examined and

increased to help control sedimentation and stream degradation in these areas. This is also recommended for controlling spikes seen in water temperature monitoring. Agricultural lands tend to provide less than a desirable amount of shade for a stream, allowing the water to be exposed to more sunlight, causing warmer temperatures. The same holds true with roads.

Additionally between stations UPPR206 and UPPR207, there is a culvert that has scoured away on the downstream side causing a fish blockage. This is a known problem, and is in the planning stage for restoration within Montgomery County's Department of Environmental Protection.

In conclusion, it is recommended that stations UPHR201, UPPR207, UPPR208, and UPPR201A have follow up habitat surveys and temperature monitoring. It is also recommended that above stream of these sites riparian buffers be examined to determine if any improvements can be made which would help maintain and/or improve the condition of the stream. Physiochemical parameters were measured at all sites and showed no impairment, at this time it is not recommended as part of a follow up study.

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